

The invention claimed is:

1. A process for depositing an electrically conductive material on a selected surface of a dielectric substrate, comprising:

depositing on a selected surface of a dielectric substrate a radially-layered dendritic copolymer having a hydrophilic interior and a hydrophobic exterior;

5 cross-linking the radially-layered dendritic copolymer to form a dendritic polymer network;

sorbing metal cations into the cross-linked dendritic polymer network;

10 reducing the metal cations in the cross-linked dendritic polymer network to form a nanocomposite composition having elemental metal atoms contained in the cross-linked dendritic polymer network, whereby the nanocomposite composition exhibits adequate surface electrical conductivity for electroplating; and

electroplating a metal onto the nanocomposite composition to form an electrically conductive deposit.

2. The process of claim 1, wherein the hydrophobic exterior of the radially-layered dendritic polymer has an organosilicon composition.

3. The process of claim 1, wherein the radially-layered dendritic copolymer is the product of a hydrophilic dendritic polymer and an organosilicon modifier.

4. The process of claim 1, wherein the radially-layered dendritic copolymer is a PAMAMOS dendrimer having a hydrophilic PAMAM interior and an organosilicon exterior.

5. The process of claim 1, wherein the radially-layered dendritic copolymer is a PPIOS dendrimer having a hydrophilic PPI interior and an organosilicon exterior.

6. The process of claim 1, wherein the radially-layered dendritic copolymer is a hyperbranched polymer.

7. The process of claim 1, wherein the radially-layered dendritic copolymer is a hyperbranched polymer having a hydrophilic poly(propyleneimine) interior and an organosilicon exterior.
8. The process of claim 1, wherein the radially-layered dendritic copolymer is a hyperbranched polymer having a hydrophilic poly(amidoamine) interior and an organosilicon exterior.
9. The process of claim 1, wherein the radially-layered dendritic copolymer is a hyperbranched polymer having a hydrophilic interior and a hydrophobic exterior.
10. The process of claim 1, wherein the radially-layered dendritic copolymer is a hyperbranched polymer having a hydrophilic polyamide interior and an organosilicon exterior.
11. The process of claim 1, wherein the radially-layered dendritic copolymer is the product of a hydrophilic dendritic polymer and an organosilicon modifier having the formula:

$$\text{XSiR}_n \text{Y}_{(3-n)} \text{ or } \text{XR}''_p \text{Y}_{2-p} \text{Si}(\text{OSiR}''_2)_m \text{OSiR}''_n \text{Y}_{3-n}$$
wherein m represents zero to 100; n represents zero, one, two, or three; and p represents zero, one, or two; X can be any group that reacts with $-\text{NH}_2$; and Y represents a group that does not react with $-\text{NH}_2$.
12. The process of claim 11, wherein X is selected from $\text{CH}_2=\text{CHCOO}(\text{CH}_2)_3-$, ClCH_2- , BrCH_2- , ICH_2- , epoxy, $\text{ClCO}(\text{CH}_2)_a-$, $\text{R}'''\text{OCO}(\text{CH}_2)_a-$, $\text{NCO}-\text{R}'''-$, and $\text{NCOCH}_2\text{CH}=\text{CH}-$, wherein a in these other groups represents an integer having a value of 1–6, R, R', R'', R''', and R''' are alkyl radicals containing 1–6 carbon atoms or a fluoroalkyl radical containing 1–6 carbon atoms.
13. The process of claim 11, wherein Y is selected from vinyl, allyl, $-\text{OR}$, hydrogen, a triorganosiloxy radical, and a ferrocenyl radical.

14. The process of claim 3, wherein the organosilicon modifier is selected from the group consisting of (3-acryloxypropyl)methyldimethoxysilane, (3-acryloxypropyl)bis(vinyldimethylsiloxy) methylsilane, (3-acryloxypropyl)dimethylmethoxysilane, (3-acryloxypropyl)-trimethoxysilane, and chloromethyldimethylvinylsilane, iodomethyldimethylvinylsilane, and chloromethyldimethylallylsilane, etc.

15. The process of claim 1, wherein the radially-layered dendritic copolymer is the product of a PAMAM dendrimer and an organosilicon modifier represented by the formula:

$\text{XSiR}_n \text{Y}_{(3-n)}$ or $\text{XR}''_p \text{Y}_{2-p} \text{Si}(\text{OSiR}''_2)_m \text{OSiR}''_n \text{Y}_{3-n}$ wherein m represents zero to 100; n represents zero, one, two, or three; and p represents zero, one, or two; X is selected from $\text{CH}_2 = \text{CHCOO}(\text{CH}_2)_3 -$, $\text{ClCH}_2 -$, $\text{BrCH}_2 -$, $\text{ICH}_2 -$, epoxy, $\text{ClCO}(\text{CH}_2)_a -$, $\text{R}'''\text{OCO}(\text{CH}_2)_a -$, $\text{NCO}-\text{R}''' -$, and $\text{NCOCH}_2 \text{CH} = \text{CH} -$, wherein a in these other groups represents an integer having a value of 1-6, R, R', R'', R''', and R''' are alkyl radicals containing 1-6 carbon atoms or a fluoroalkyl radical containing 1-6 carbon atoms; and Y is selected from vinyl, allyl, -OR, hydrogen, a triorganosiloxy radical, and a ferrocenyl radical.

16. The process of claim 15, wherein the PAMAM dendrimer is a generation 0, 1, 2, 3 or 4 dendrimer.

17. The process of claim 1, wherein the radially-layered dendritic copolymer is the product of a PPI dendrimer and an organosilicon modifier represented by the formula:

$\text{XSiR}_n \text{Y}_{(3-n)}$ or $\text{XR}''_p \text{Y}_{2-p} \text{Si}(\text{OSiR}''_2)_m \text{OSiR}''_n \text{Y}_{3-n}$ wherein m represents zero to 100; n represents zero, one, two, or three; and p represents zero, one, or two; X is selected from $\text{CH}_2 = \text{CHCOO}(\text{CH}_2)_3 -$, $\text{ClCH}_2 -$, $\text{BrCH}_2 -$, $\text{ICH}_2 -$, epoxy, $\text{ClCO}(\text{CH}_2)_a -$, $\text{R}'''\text{OCO}(\text{CH}_2)_a -$, $\text{NCO}-\text{R}''' -$, and $\text{NCOCH}_2 \text{CH} = \text{CH} -$, wherein a in these other groups represents an integer having a value of 1-6, R, R', R'', R''', and R''' are alkyl radicals containing 1-6 carbon atoms or a fluoroalkyl radical containing 1-6 carbon atoms; and Y is selected from vinyl, allyl, -OR, hydrogen, a triorganosiloxy radical, and a ferrocenyl radical.

18. The process of claim 17, wherein the PPI dendrimer is a generation 1, 2, 3 or 4 dendrimer.
19. The process of claim 1, wherein cross-linking is achieved by hydrolysis of $\equiv\text{SiCl}$ or $\equiv\text{Si}-\text{OR}$ end-groups of the radially-layered dendritic copolymer.
20. The process of claim 1, wherein cross-linking is achieved by hydrosilation or thiol addition reaction.
21. The process of claim 1, wherein cross-linking is achieved by Michael addition reaction.
22. The process of claim 1, wherein cross-linking is achieved by condensation reactions.
23. The process of claim 1, wherein the metal cations sorbed into the cross-linked dendritic polymer network are Cu^{+2} ions.
24. The process of claim 23, wherein the Cu^{+2} ions are sorbed into the dendritic polymer network by contacting the dendritic polymer network with a copper acetate or copper sulfate solution.
25. The process of claim 23, wherein the reduction of Cu^{+2} ions is achieved by contacting the dendritic polymer network containing sorbed Cu^{+2} ions with a sodium borohydride solution.
26. The process of claim 1, wherein the electroplating is achieved in a copper pyrophosphate bath.

27. The process of claim 1, wherein the selected surface of the dielectric substrate on which the radially-layered dendritic copolymer is deposited is a wall of a through-hole in the dielectric substrate, whereby the electrically conductive deposit forms an electrically conductive pathway from one side of the substrate to another side of the substrate.

28. The process of claim 1, wherein the electrically conductive material is deposited on selected surfaces of the dielectric substrate to form an electrical circuit pattern.

29. The process of claim 1, wherein deposition of the electrically conductive material on the selected surfaces of the dielectric substrate is achieved by direct printing of a coating composition containing the radially-layered dendritic copolymer to the selected surfaces of the substrate in a pattern that corresponds with a desired pattern of the electrically conductive deposit.

30. The process of claim 29, wherein direct printing of the radially-layered dendritic copolymer onto the selected surfaces of the substrate is achieved with a plotter pen, transfer printing, rubber-stamping or inkjet printing.

31. The process of claim 1, wherein depositing of the electrically conductive material on the selected surfaces of the dielectric substrate is achieved by selectively sorbing the metal cations in the cross-linked dendritic polymer network in a pattern corresponding with a desired electrically conductive deposit.

32. The process of claim 1, wherein selective sorption of metal cations in a desired pattern is achieved by masking portions of the cross-linked dendritic polymer network where metallization is not desired, and contacting areas exposed through the mask with a solution containing metal cations.

33. The process of claim 1, wherein a desired pattern of electrically conductive material is deposited on the dielectric substrate by etching or scribing the desired pattern in the dielectric substrate prior to depositing the radially-layered dendritic copolymer on the dielectric substrate, the etching or scribing forming a trench pattern on the dielectric substrate, and
5 depositing the radially-layered dendritic copolymer only in the trench pattern prior to cross-linking the radially-layered dendritic polymer.

34. The process of claim 1, wherein a desired pattern of electrically conductive material is deposited on the dielectric substrate by removing cross-linked radially-layered dendritic copolymer from the dielectric substrate wherever metallization is not desired prior to electroplating the metal onto the nanocomposite composition.

35. The process of claim 1, wherein a desired pattern of electrically conductive material is deposited on the dielectric substrate by application of a mask over the cross-linked dendritic polymer network, formation of a trench pattern in the mask to a sufficient depth to expose the underlying cross-linked radially-layered dendritic polymer prior to sorbing metal cations into the cross-linked dendritic polymer network, whereby the patterned mask allows sorption of
5 metal cations into exposed areas of the dendritic polymer network and prevents sorption of metal cations into the masked areas of the dendritic polymer network.

36. The process of claim 1, wherein a desired pattern of electrically conducting material is deposited on the dielectric substrate by application of an ink mask over the copper nanocomposite of the cross-linked dendritic polymer network coating wherever metallization is desired prior to electroplating and the coating is then immersed in an aqueous solution of
5 ammonium persulfate whereby etching unwanted copper nanocomposite, subsequent removal of the ink mask and subsequent electroplating of the remaining circuit or decorative pattern.